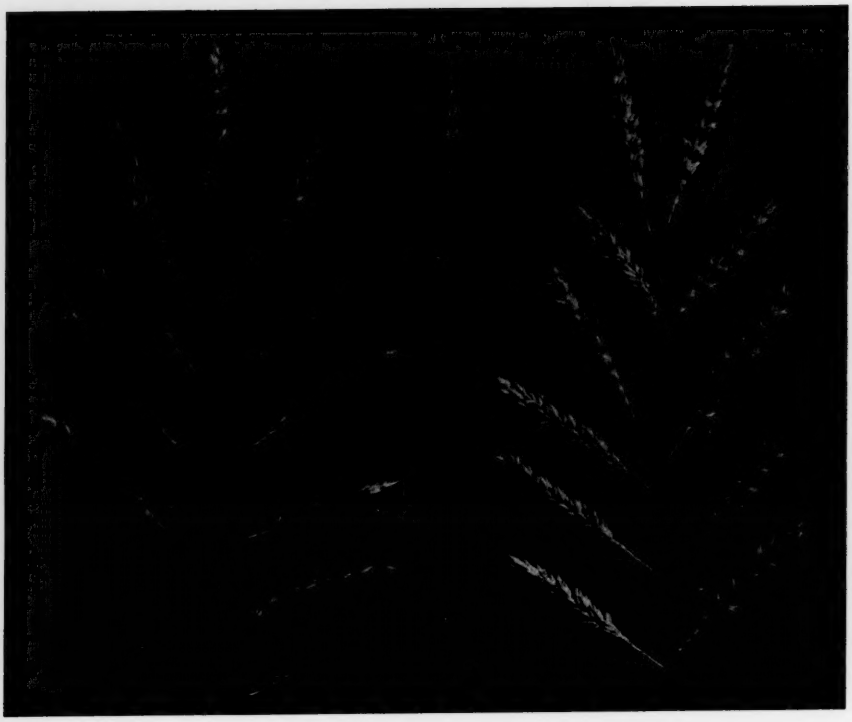
The Journal of HEREDITY



PROGENY OF AWNED WHEAT CHIMERA
(SEE PAGE 75)

Varied Wing-Notching in Drosophila

An Odd-Rowed Strain of Maize

The Svalof Plant-Breeding Station

Interlocked Chromosomes to Order

von Tschermak-Seysenegg—Surviving Mendel Re-Discoverer

VOLUME 40 MARCH, 1949 NUMBER 3

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President — Vice-President, SEWALL WRIGHT

Honorary Vice-Presidents, W. E. CASTLE, O. F. COOK

C. E. LEIGHTY, Secretary — Treasurer, SAMUEL L. EMSWELLER

Managing Editor, ROBERT C. COOK

EDITORIAL BOARD

M. DEMEREC — RALPH W. PHILLIPS

H. J. MULLER — LAURENCE H. SNYDER — PAUL POPENOE

Members of the Council are ex-officio members of the Executive Board

COUNCIL

O. S. AAMODT, Head Agronomist, Division of Forage Crops and Diseases, Plant Industry Station, Beltsville, Md.

RONALD BAMFORD, Professor of Botany, University of Maryland, College Park, Md.

GEORGE M. DARROW, Horticulturist in Charge of Small-Fruit Breeding, Horticultural Field Station, Beltsville, Maryland.

SAMUEL L. EMSWELLER, Principal Horticulturist, Division of Fruit and Vegetable Crops and Diseases, Plant Industry Station, Beltsville, Md.

DAVID FAIRCHILD, Agricultural Explorer (Retired), U. S. Department of Agriculture.

W. V. LAMBERT, University of Nebraska, Lincoln, Nebraska

C. E. LEIGHTY, Agronomist (Retired), U. S. Department of Agriculture.

HUGH C. McPHEE, Assistant Chief of Animal Husbandry Division, U. S. Department of Agriculture, Washington, D. C.

FREDERICK H. OSBORN, Deputy United States Representative on the United Nations Atomic Energy Commission, and on the United Nations Commission for Conventional Armaments.

MARCUS M. RHOADES, Professor of Botany, University of Illinos, Urbana, Illinois.

WILLIAM VOGT, Chief, Conservation Section, Pan American Union, Washington 25, D. C.

SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.

E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.

E. A. BESSEY, Professor of Botany, Michigan State College, Lansing, Michigan.

A. F. BLAKESLEE, Professor of Botany, Smith College, Northampton, Mass.

W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.

RUSSELL W. DUCK, Editor, *The Rural New Yorker*. New York City.

C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.

C. M. GOETHE, Sacramento, California.

HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.

D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

M. A. JULL, Professor of Poultry Husbandry, University of Maryland, College Park, Md.

C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.

H. H. NEWMAN, Emeritus Professor of Zoology, University of Chicago, (Clearwater, Fla.).

T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.

JOHN H. PARKER, Director, Midwest Barley Improvement Association, Milwaukee, Wisconsin.

JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.

A. D. SHAMEL, Physiologist, U. S. Department of Agriculture, Riverside, California.

GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.

EDMUND W. SINNOTT, Professor of Botany, Yale University, New Haven, Conn.

W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.

A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.

W. T. SWINGLE, Plant Physiologist (Retired). U. S. Department of Agriculture.

W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.

E. N. WENTWORTH, Armours' Bureau of Agr'l Research and Economics, Chicago, Illinois.

P. W. WHITING, Zoological Laboratory, University of Pennsylvania, Philadelphia, Pa.

The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 32nd Street and Elm Avenue, Baltimore 11, Md., and 1507 M St., N. W., Washington 5, D. C. Address all communications regarding editorial matters to 1507 M. St., N. W., Washington, D. C. Communications regarding the business management of THE JOURNAL OF HEREDITY may be addressed to the publication office, 32nd Street and Elm Avenue, Baltimore, Md., or to 1507 M St., N. W., Washington 5, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103. Act of October 3, 1917 authorized December 29, 1918.

Contents copyrighted 1949 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office.

$5.00 a Year. 50c a Copy. Prices of back numbers on application.

The

Journal of Heredity

Vol. XL **MARCH, 1949** **No. 3**

CONTENTS

Varied Expressivity of "Notched" Mutation in *Drosophila Macrospina*
By Sidney Mittler 59

A Corn With Odd-Rowed Ears
By I. W. Hepperly 63

Increase in Bivalent Interlocking
By J. Herbert Taylor 65

Erich von Tschermak-Seysenegg
By Felix Kiefer 71

An Awn Chimera in Marquillo Wheat
By L. P. Reitz 75

Notes and Reviews

Down the Rat-Hole 64

A Bud Variation in Bouganvillea
By Fernando Villamil G. 69

Marxist Biology, French Style
By Th. Dobzhansky 78

The Svalof Plant Breeding Station
By H. K. Hayes 80

In Praise of the Quarter Horse
By Dewey G. Steele 83

The Formation of Flowers
By J. van Overbeek 84

— URGENTLY NEEDED —

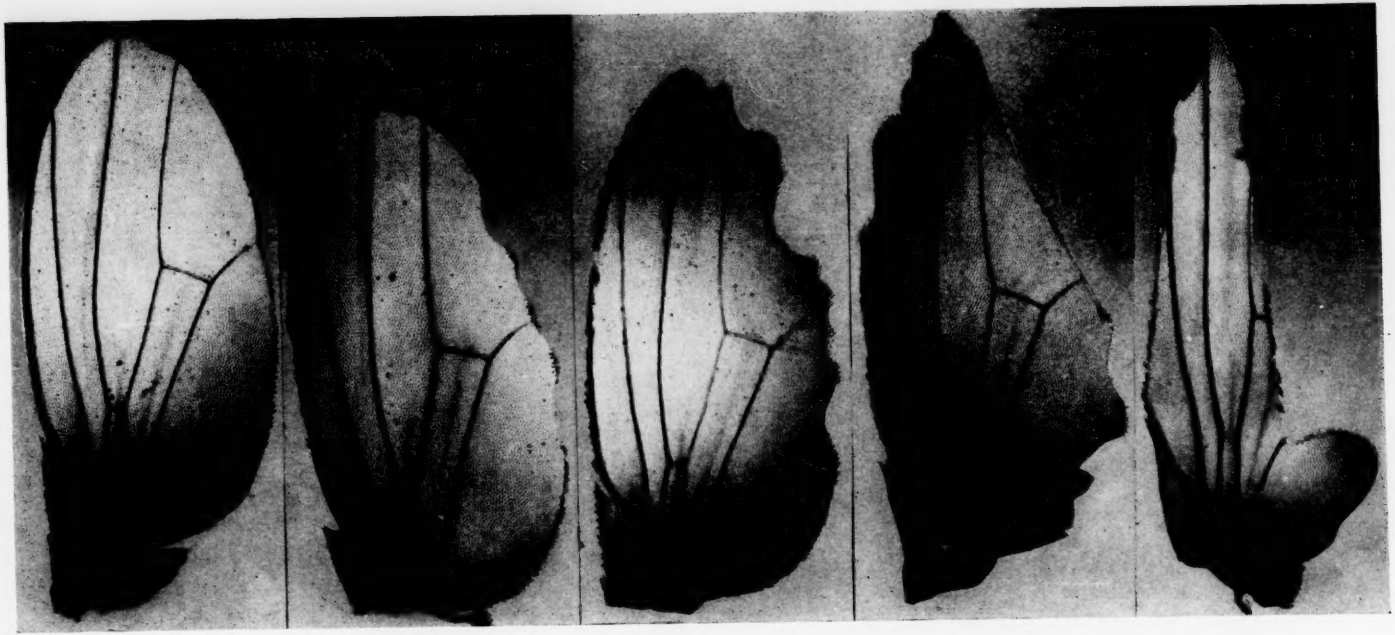
The following two issues of the JOURNAL OF HEREDITY are exhausted:

THESE ISSUES—OCTOBER 1945, FEBRUARY 1947— ARE URGENTLY NEEDED TO COMPLETE LIBRARY FILES.

Members will confer a favor by returning unwanted copies to us so that war-devastated libraries may be furnished with unbroken series.

WE WILL PAY $1.00 PER COPY FOR EACH OF THESE ISSUES OF THE *JOURNAL*.

Mail copies to
AMERICAN GENETIC ASSOCIATION
1507 M. Street, N. W. ***Washington 5, D. C.***



CLASSES: 1 2 3 4 5

RANGE OF VARIATION

Figure 1

The five classes of notched male wings are illustrated in this series; the sixth class, normal "wild-type" wings, being notch-free. "Notched" is a sex-linked recessive gene. The total genetic constitution of different populations tested affected the extent of notching to a very marked degree.

VARIED EXPRESSIVITY OF "NOTCHED"

Geographic Variation in the Penetrance and Expressivity of the "Notched" Mutation in *Drosophila Macrospina*

SIDNEY MITTLER
Illinois Institute of Technology

AN attempt was made to discover whether genetic variability existed in different populations of *D. macrospina limpiensis, D. macrospina macrospina, D. macrospina ohioensis** by the influence of genetic modifiers in these populations on the variable mutation notched. A mutation that has a variable degree of expressivity is usually affected either by a change in temperature, food and culture conditions, or by modifying genes. Hence by keeping the temperature and culture conditions constant, the effect of the modifying genes on the mutation can be ascertained. The mutation, notched, is usually recessive, and is on the *X*-chromosome. It first appeared on April 18, 1944, in X-rayed stock of *D. m. limpiensis* from Limpia Canyon, Davis Mts., Texas. The phenotypic effect of the mutation is to remove portions of the posterior and medial margins of the wings. The expressivity of the mutation was grouped into six classes, ranging from wild type (no effect) to the extreme type (class 5) in which a narrow blade of wing tissue remains (Figure 1).

Method

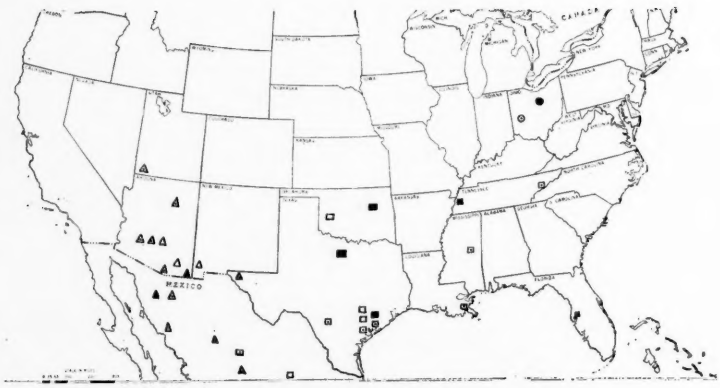
The standard or control expressivity of notched was determined from the stock of *D. m. limpiensis* from Limpia Canyon, Texas (L stock) which was reared at 20°C. The majority of the male flies containing the notched genes were placed into classes two and three (Table I). The wings of the females had more wing tissue removed by the mutation than in the case of males.

Since it is difficult to take the mutation, notched, alone and place it at will with other chromosomes, the following method was used. Homozygous notched females from a highly inbred *L* stock were crossed to males of stocks collected at various localities. Since the mutation was on the *X* chromosome, the hybrid females usually had wild type wings, and the males had notched wings. The males were then classified into the proper groups as to the amount of wing tissue remaining. One of each pair of autosomes and the *X* chromosome came from the *L* stock; the other set of autosomes and the *Y* chromosome were supplied by the male from the locality tested. The variation in the expression of notched in these males could be due to the modifying genes introduced by the male or to the new combination of genes present. If the expression of notched is repressed or exaggerated, this may be taken to indicate a genetic difference. However, the method does not distinguish the actual number of modifiers present.

Results

D. m. limpiensis males (Table I) from Mangas Canyon, New Mexico, and from Sabino Canyon, Arizona, when mated to homozygous notched females from the *L* stock, produced males whose wings approached wild type; i.e. the expressivity of the *n* gene was weaker than in the inbred control stock (*L*). A stronger degree of expressivity of the *n* gene is found in crosses employing *D. m. limpiensis* males from San Bernardino, Ariz., and Sierra Ancha, Arizona. Males from twelve other localities had no apparent phenotypic effect on the expression of the *n* gene.

*The stocks of *D. m. limpiensis* and *D. m. macrospina* used in the above experiments were from the collection of Dr. G. B. Mainland.



LOCATION OF TEST-POPULATIONS

Figure 2

The black symbols designate populations whose male hybrids with the tester strains showed a strong expressivity; the dotted symbols show populations with a standard expressivity; and the open symbols, a weak expressivity. Triangles denote *D. m. limpiensis*; squares denote *D. m. macrospina*; and circles *D. m. ohioensis.*

The males of *D. m. macrospina* (Table II) from nine localities had no influence upon the *n* gene. However, males from Austin, and from Belton, Texas, from Ramos Arizpe, Mexico, and from the Wichita Mts., Oklahoma, contained genetic modifiers that weakened the expressivity of *n*. Males from Fort Worth, Texas, San Gabriel Park, Texas, Tulsa, Oklahoma, and Shelby Forest, Tennessee, increased the degree of notching. The mutation acted as a dominant in crosses with *D. m. macrospina* males from San Gabriel Park, Texas, and *D. m. ohioensis* males from Wooster, Ohio, in that females heterozygous for the *n* gene possessed notched wings. In the other crosses all the F_1 females were of wild type.

Discussion

A study of the localities tested, indicates that there is no clean-cut geographic gradient present with respect to genetic modifiers of expressivity of the *n* gene. For example, the Sabino Canyon population in Southeastern Arizona, giving a weak expressivity, is located between two populations with a stronger expressivity, San Bernardino and Sierra Ancha, Arizona (Figure 2). In south central Texas populations with weak and strong expressivity are found close together. In Oklahoma both strong and weak strains are found.

How can one explain this spotty distribution of populations with various degrees of expressivity of the *n* gene? This mutation may not occur in nature, for it was produced by means of X-rays. If it does occur in nature, there would be a selection against the gene or a selection for modifying genes that repressed the expressivity of *n*. The absence of a gradient of expressivity may be due to random distribution of modifying genes or of gene arrangements that effect the gene. The method used in testing the males of various localities as to the extent of *n* gene expression, does not distinguish between a cumulative effect of several weak modifying genes or one strong modifying gene. It is also possible that various genes, or gene arrangements, are present that have no phenotypic effect upon the wing but in combination with other gene or gene arrangements alter the expression of the mutant gene.

Again there is no gradient present with respect to dominance of the *n* gene. The F_1 males of the above crosses were

all strongly notched. If the right combination of modifying factors were present, or if the requisite chromosome rearrangements occurred, it is possible that the *n* gene, instead of acting as a recessive was able to affect the phenotype in the heterozygote, as in the two instances above noted. There is a possibility that mutations affecting the *n* gene may have occurred in the test stocks before the matings were made. Selection in the culture bottles prior to mating of the males may explain the spotty geographic distribution of modifiers.

D. m. macrospina and *D. m. ohioensis* are eastern forms. *D. m. limpiensis* is found in extreme western Texas and in Arizona and New Mexico. Mainland[1] reported that when *D. m. macrospina* and *D. m. ohioensis* are crossed, inbred, and backcrossed, no sterility is encountered. However, in crosses involving females of *D. m. limpiensis* with *D. m. macrospina* and *D. m. ohioensis,* all F_1 males are sterile and F_1 females are fertile. From a study of the data there is no increase or decrease in expressivity in the *n* gene where males of *D. m. macrospina* or *D. m. limpiensis* are crossed to female *D. m. limpiensis*. The *limpiensis Y* chromosome, which is necessary for fertility in males possessing a *limpienses X*, does not have any influence on the expression of the gene *n*.

If the flies were reared at temperatures above 22°C, expressivity of the *n* gene was decreased, and the wing assumed a wild type shape. This may mean that the modifying genes shorten or lengthen the larval life, or speed up or slow down some chain of chemical reactions, that enables the wing-destroying or inhibiting substance to act over a longer or shorter period of time.

TABLE I. n/n ♀ of *D. m. limpiensis* (Limpia Canyon, Tex.) × ♂ *D. m. limpiensis* at 20°C.

Stock	Class of Notched Wing (♂)					
	+	*1*	*2*	*3*	*4*	*5*
n stock (Limpia Canyon, Texas)	0	48	417	562	61	0
Limpia Canyon, Texas	2	14	53	88	25	0
Chihuahua, Mexico	2	1	6	36	22	0
Cave Creek, Arizona	0	9	102	107	0	0
Hassayampa River, Arizona	0	8	112	95	2	0
Hermosillo, Sonora, Mexico	0	6	163	150	3	0
Lerdo, Durango, Mexico	0	10	124	41	0	0
Oak Creek Canyon, Arizona	0	0	53	27	0	0
Patagonia, Arizona	0	0	31	271	0	0
Punta del Aqua, Sonora, Mexico	0	41	182	103	0	0
Zion National Park, Utah	0	0	31	83	9	0
Magdalena, Sonora, Mexico	5	60	293	94	0	0
San Bernardino, Arizona	0	0	51	214	113	0
Sierra Ancha, Arizona	0	0	0	183	27	0
Mangas Canyon, New Mex.	0	63	297	103	0	0
Sabino Canyon, Arizona	0	127	154	23	0	0

TABLE II. n/n ♀ of *D. m. limpiensis* (Limpia Canyon, Tex.) × ♂ *D. m. macrospina* at 20°C.

Stock	Class of Notched Wing (♂)					
	+	*1*	*2*	*3*	*4*	*5*
Aldrich Farm, Texas	0	21	132	74	23	0
Almo Canon, Mexico	0	0	53	231	21	0
Columbus, Mississippi	0	5	26	12	1	0
Fayette County, Texas	0	0	42	36	0	0
Lake McKettan, Florida	3	7	25	31	4	0
Mason County, Texas	10	6	5	24	5	0
Great Smoky Mts., Nat'l. Park, Tenn.	0	0	0	26	13	0
New Orleans, Louisiana	2	6	10	22	6	0
Onion Creek, Texas	0	0	32	26	10	0
*Piqua, Ohio	0	2	33	19	1	0
Fort Worth, Texas	0	0	20	222	64	0
San Gabriel Park, Texas	0	0	0	61	223	340
Tulsa, Oklahoma	0	0	7	38	191	101
Shelby Forest, Tennessee	0	0	10	138	76	0
*Wooster, Ohio	0	0	51	62	114	0
Austin, Texas	75	69	39	4	0	0
Belton, Texas	44	24	10	0	0	0
Ramos Arizpe, Coah., Mexico	51	172	174	0	0	0
Witchita Mts., Oklahoma	0	101	96	0	0	0

*Males used were *D. m. ohioensis*.

If the modifying genes were reared at temperatures above 22°C, expressivity of the *n* gene was decreased, and the wing assumed a wild type shape. This may mean that the modifying genes shorten or lengthen the larval life, or speed up or slow down some chain of chemical reactions, that enables the wing-destroying or inhibiting substance to act over a longer or shorter period of time.

Summary

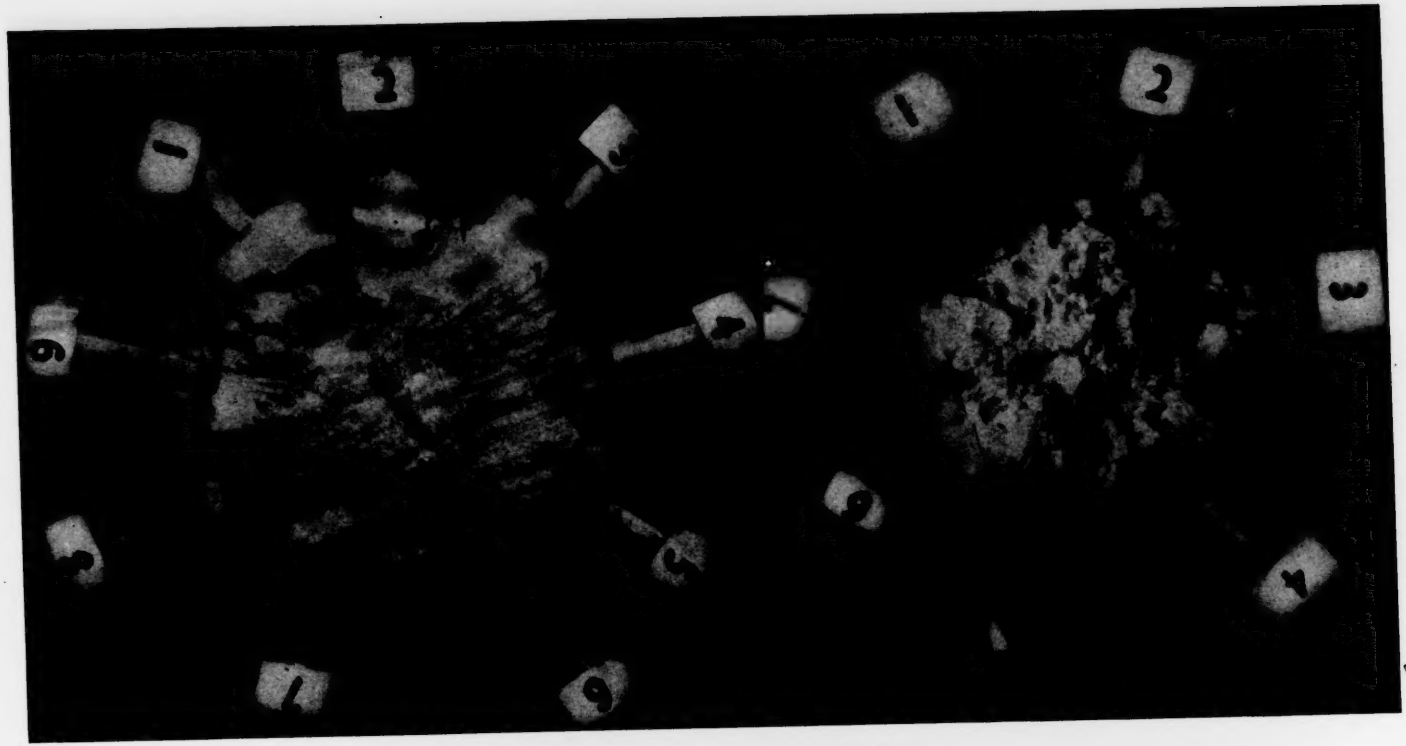
Genetic variability in 35 populations of *D. m. limpiensis, D. m. ohioensis,* and *D. m. macrospina* was demonstrated by crossing males from the various localities to females homozygous for recessive sex-linked gene, notched, from Limpia Canyon, Texas. The variation in expressivity of the gene in F_1 males gave an indication of presence of modifiers. In two of the crosses the notched gene acted as a dominant mutation. There was no clean-cut geographic gradient as determined for expressivity or penetrance by this method.

Literature Cited

1. MAINLAND, G. B. *Genetics* 26:160-1. 1941.

✦

The Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, destroyed by fire last year, urgently needs the following issues of the JOURNAL OF HEREDITY: Complete volumes: 1, 2, 3, 4. Volume 5, #1 and #2. Volume 38, #2.



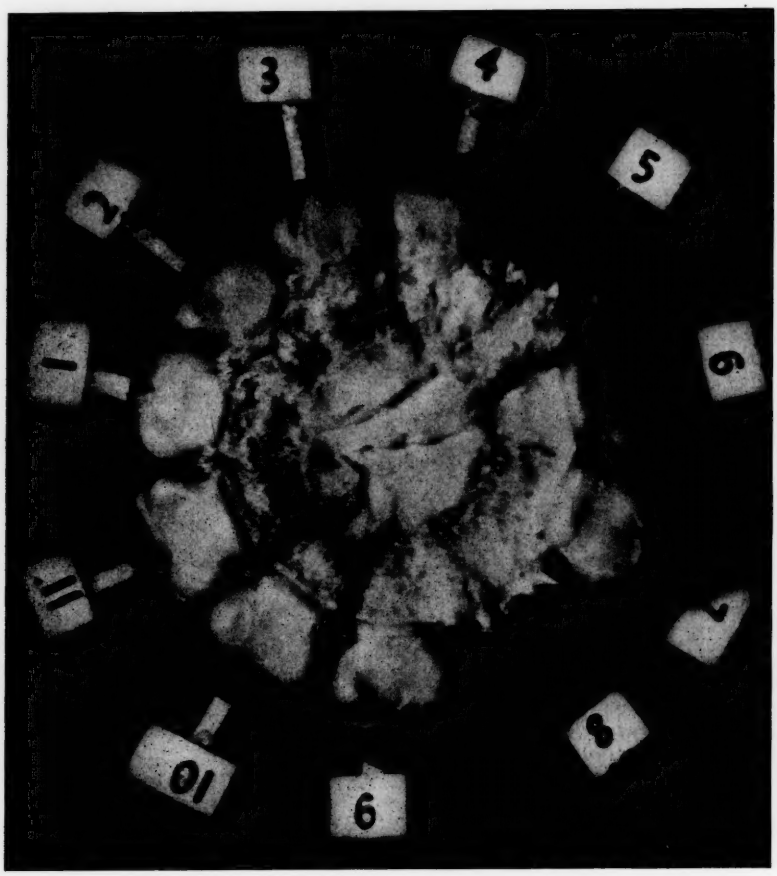
NINE-ROWED AND SEVEN-ROWED EARS

Figure 3

The rows of kernels on the normal ear arise from paired spikelets; hence there are always an even number of rows. Single spikelets produce ears with an odd number of rows—a very rare phenomenon.

A CORN WITH ODD-ROWED EARS

I. W. Hepperly*



AN ODD-ROWED EAR

Figure 4

From a unique nine-rowed ear, 14 plants having odd-rowed ears were obtained. The inheritance of this deviation is being investigated.

A nine-rowed ear of maize was discovered during the process of ear sorting a commercial seed crop for the J. C. Robinson Seed Company, Waterloo, Nebraska. This ear represented the detasseled parental single cross of a commercial 4-way hybrid. At least 100,000 bushels of this particular single cross have been sorted. Previously, no case of this kind has come to the attention of those sorting the ears.

Grains of this nine-rowed ear were

*Research Director, J. C. Robinson Seed Company, Waterloo, Nebraska.

The rows of kernels on the normal ear arise from paired spikelets; ears with an odd number of rows—a very rare phenomenon.

planted in 1947 and odd rowed as well as even rowed ears were produced. The following row numbers were harvested; 6 7 8 9 10 11 13 14 18 20 22 24. Ears with 13 rows or less show the single spikelet characteristic and ears with 14 rows and greater produced the usual paired spikelet condition.

An examination of the cob of the original ear as well as odd rowed ear progenies showed lack of paired kernel rows. Odd rows of grains arise from a single spikelet condition. The usual condition for corn is the paired spikelet situation producing even rowed ears of corn. No indication of a division of vascular bundles is apparent.

At harvest of the 1947 progeny from the original odd rowed ear, those plants yielding odd rowed ears showed tassel variation.

Self pollinations were made and a planned testing program is underway to determine the genetic nature of this character. Of the 25 self pollinated ears, 14 were single spikelet types and 11 were paired spikelet ears. The 1947 population produced 38 ears and from these 15 were odd rowed types; however, 10 even rowed types were of the single spikelet variety. The relation of this genetic material to the type Langham[1] described from a Maize-Teosinte cross has not been clarified. If the present case is a mutation in Maize and essentially a Teosinte characteristic this type is of interest in light of Mangelsdorf's[2] theory of the origin of Indian Corn in which he thinks Teosinte played a role.

Literature Cited

1. Langham, D. G. *Genetics* 25:105. 1940.
2. Mangelsdorf, P. C. *Jour. Hered.* 38: 1947.

✦

Jackson Laboratory Twenty Years Old

The Roscoe B. Jackson Memorial Laboratory will commemorate its 20th anniversary during the year 1949. The theme of the commemoration will be "Twenty years of research at the Jackson Laboratory," and one of the principal activities will be a series of papers given during the summer session in honor of Dr. C. C. Little, founder and director since 1929. In addition, there will be a reunion of friends of the laboratory, together with former students, summer investigators, and staff members during August 18th to 21st. Since some records were lost in the fire of 1947, all persons who do not receive invitations and who wish to attend are asked to write to the Chairman, Jackson Laboratory 20th Commemoration, Bar Harbor, Maine.

✦

Down the Rat-Hole

Talkers are no great doers. And the assumed great minds are great talkers.

The impression is that the group making this report* was hypnotized by the New Deal concept that all one needs to do is to spend money and every problem will be solved. Nowhere do I find statement of the two great present-day needs of science: viz.

1. Ideas. And the brains and background training in direction (genetics); substance (chemistry); state of substance (physics); and form (anatomy, cytology) to work out ideas comprehensively and intelligently. There are no boundaries in science; only interdependencies.

2. A college of integrators, the function of the members of which would be to attempt to bring some order out of the chaos resulting from the publication of 10^6 reports on science work each year. Through tracing out the roots; growth; ramifications; impact and interdependencies of each concept of general applicability.

This 95-page report is one reason why the taxes you pay are sluiced down the well-known rat-hole to complete and utter wastage. To get anything out of it is like trying to grasp a handful of mercury from a bowl of that elusive element.

F. S. Hammett
Lankanau Hospital
Research Institute, Philadelphia

*United Nations Educational Scientific and Cultural Organization Report on the Question of United Nations Research Laboratories and Observatories. Pp. 96, mimeographed, Paris, 1947.

INCREASE IN BIVALENT INTERLOCKING

And Its Bearing on the Chiasma Hypothesis of Metaphase Pairing*

J. HERBERT TAYLOR

THE occurrence of interlocked bivalents has been noted in a number of organisms (see Darlington[3] for references). Sax and Anderson[4] made an analysis of the frequency of interlocks in a number of species of *Tradescantia*. These interlocking bivalents (Figure 5*B* and *D*) do not usually affect the normal segregation of chromosomes, but it has long been recognized that their analysis may throw light on the mechanism of crossing-over and chiasma formation. The increased frequency of interlocks in cells from anthers excised and cultured in nutrient media is surprising and perhaps significant from this point of view.

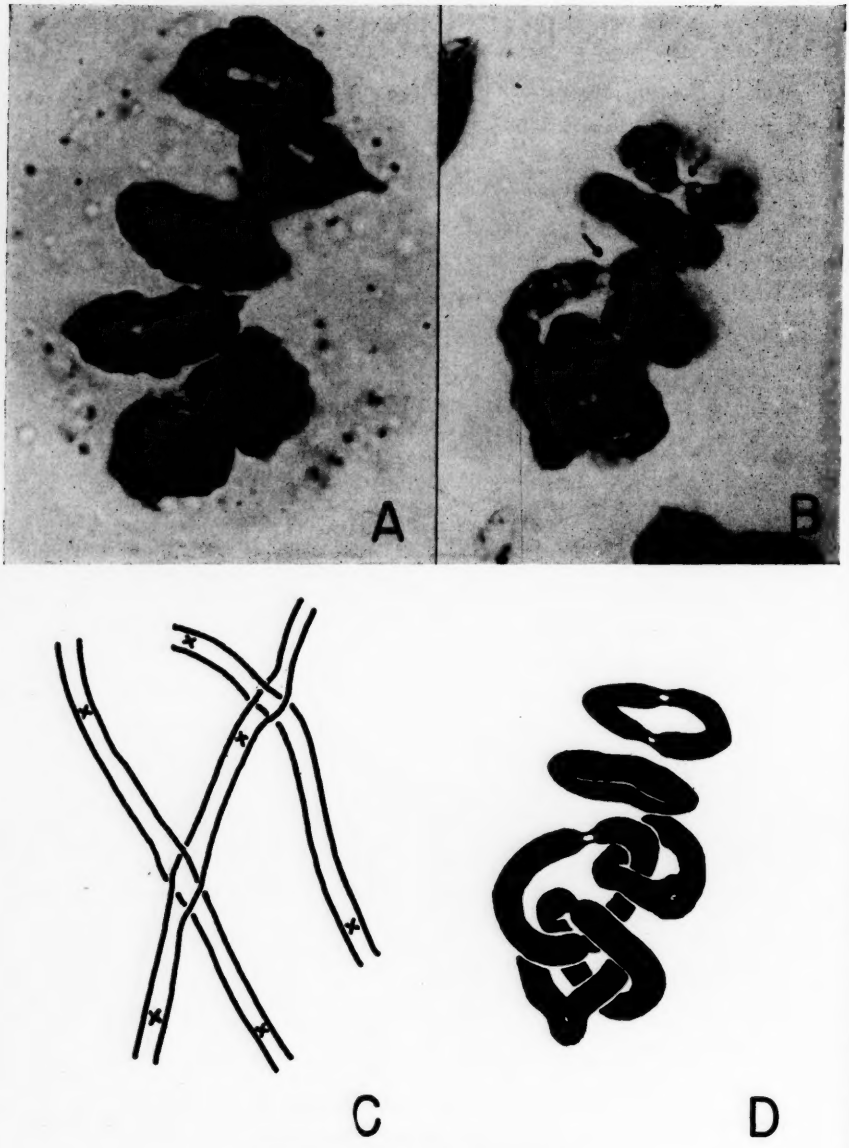
Anthers of a clone of *Tradescantia paludosa*,† excised at stages as early as leptotene of first meiotic prophase and grown in culture,[6,7] proceed through essentially normal divisions up to the formation of tetrads of microspores. Determination of the stage of division at excision was based on an examination of two of the six anthers from each flower. In young inflorescences there is a high degree of synchronization among anthers of a single flower and among different cells of an anther. A further check on stages at excision may be made by comparing the time required by different anthers of an estimated stage to reach metaphase I in the same medium at constant temperature. Temperature in the greenhouse in late June and early July when these experiments were in progress fluctuated between 25° and 35°C. The anthers after excision were cultured at 13°, 25°, or 30°. Anthers were fixed, squashed and stained with aceto-orcein (solution of orcein in 60% glacial acetic acid) in the usual way and compared with those from plants growing in the greenhouse at the same season of the year.

Results

When anthers were allowed to remain on the plant until metaphase I, 25 per cent of the cells contained interlocked bivalents (Table I). The number of bivalents involved varied from two to five, with two being predominant. Only one case of five was recorded. Mean frequency of interlocks per cell for eleven anthers from different plants was 0.31 ± 0.036. These counts were taken during the same period as those for cultured anthers, since interlocking varies with the season. Anthers excised and cultured at 30°C. produced cells with a mean interlock frequency of 0.99 ± 0.073 per cell (Table II). This greater frequency is correlated with an increase in percentage of cells with interlocked bivalents, 64 per cent compared to 25. Also, more bivalents per cell are involved. The highest record was a ring of six interlocked bivalents. The significant point is that anthers, excised after pairing and pachytene interlocking (Figure 5*C*) were presumably complete, showed a marked increase in interlocking compared to those left on the plant. Synapsis in the two cases—cultures and controls—occurred under similar conditions, that is, on the plants. Then at late or mid-pachytene the anthers of some flowers were carefully excised, placed in culture and grown at a temperature not very different from that of greenhouse controls. These cultured anthers usually showed a striking increase in interlocks per cell. The mean for affected anthers is about three times that

*Published as Contribution No. 109 from the Botanical Laboratory of the University of Tennessee, Knoxville.

†Clone 5 from the laboratory of Dr. Karl Sax; received from Dr. Norman Giles, Biology Division, Oak Ridge National Laboratory.



INTERLOCKED CHROMOSOMES

Figure 5

A shows a normal cell of *T. paludosa*. *B* is a cell from an anther excised at late pachytene and cultured for 15 hours. Four of the bivalents are interlocked at metaphase I. *D* is a drawing of *B* showing the details of the interlocked bivalents. *C* shows the generally accepted explanation for interlocking—two pachytene interlocks that would produce one metaphase interlock if crossing-over occurred at the points indicated.

of the control. This increase is not accompanied by a significant change in the mean chiasma frequency at metaphase I.

Several additional observations were made which may have a bearing on the problem of interlocking. (1) Two of the anthers, excised and cultured at 13°C. during this same period, were fixed at metaphase I and interlocks recorded. One anther excised at mid-pachytene and fixed after 91 hours had a mean interlock frequency of 0.25 per cell, while another 76 hours after excision at late pachytene had an interlock frequency of 0.20 per cell. During this period, one count was made from an anther cultured at 25°C. Forty-three hours after excision at early pachytene it had reached metaphase I with an interlock frequecy of 0.20 per cell. Earlier in the spring a number of anthers cultured at 25°C. had been examined without noting any increase in interlocking, with one notable exception. This exceptional anther had an interlock frequency of 1.65. It had been excised in early pachytene and in 48 hours had reached metaphase I. While these counts are not sufficient to be used statistically, they do indicate a temperature effect on interlocking. (2) In cells from anthers cultured at 13°C., some of the bivalents are connected to each other by chromatic adhesions after they emerge from the "diffuse stage" of diplotene. These are often end to end connections, but may unite other regions of the chromosomes. Such adhesions, which evidently form during the "diffuse stage", have the appearance of chiasmata. When these adhesions unite non-homologous parts they can be recognized, but a similar mechanism uniting homologous parts could not be distinguished from those chiasmata arising from crossovers by the accepted method. The non-homologous adhesions mentioned above could be interpreted as an exaggeration of the normal uniting mechanism of diplotene and diakinesis. (3) Attempts were made to measure chiasma frequency at early diplotene, but the "diffuse stage" makes analysis difficult. Counts at early diplotene, when they could be made, revealed two or three chiasmata per bivalent in both cultured and control cells. It is impossible to know whether any of those examined would have shown increased interlocking at metaphase. In any case, very few chiasmata are canceled by terminalization before anaphase.

Discussion

How could such an increase of interlocking have occurred when the generally accepted basis for metaphase interlocks — chromosomes trapped between homologs during synapsis (Figure 5*C*) —was not different in the cultured and the control anthers? The answer is not readily apparent by any known mechanism of the chiasmatype hypothesis of metaphase association of chromosomes. According to this hypothesis interlocks at metaphase I (Figure 5*B* and *D*) would result from the occurrence of crossovers distal to the position of pachytene interlocks with respect to the centrally located centromeres (Figure 5*C*). If a constant high rate of pachytene interlocking for both cultured and control cells is assumed, there are two ways in which metaphase interlocks might increase without a change in chiasma frequency at metaphase I: (1) by a decrease in crossovers to a minimum of two per bivalent, or (2) by an increase in localization of crossovers near the ends of the bivalents.

A high crossover frequency and terminalization, reducing the metaphase chiasma frequency to two per bivalent, would push all pachytene interlocks off the ends except those between the inner two crossovers. A reduction in number of crossovers, distributed at random, would mean an increase in the mean distance between the inner two crossovers. More pachytene interlocks would be retained until metaphase. However, to explain quantitatively the increase that occurred, more than three times as many crossovers must be demonstrated in controls as in cultures. No such difference was found. If any difference exists, it is inadequate to explain the increase in interlocking.

Localization of the crossovers toward the ends of the bivalents would increase the mean distance between the inner two crossovers. This in turn would retain more interlocks at metaphase if the metaphase chiasmata are not reduced below two per bivalent. Chiasmata are normally localized distally in *Tradescantia*. Furthermore, chiasmata seen at early diplotene in cultured cells were distributed similarly to those of controls. There seems little chance for much increase in retention of interlocks by this mechanism.

By admitting the possibility that metaphase associations of homologous chromosomes are not necessarily the result of crossovers, it may be possible to explain the increase in interlocks. If a sudden change to an artificial medium should reduce the crossovers, or by some means produce a partial desynapsis, the chiasmata could in many cases be reduced to less than two per bivalent. Then during late diplotene or early diakinesis, when the chromosomes are ordinarily in a compact group in this species, a renewal of end associations could occur. This would allow additional interlocks which would be visible at metaphase. Several observations lend support to this explanation. (1) In some cultured anthers excised during leptotene, a high percentage of desynapsis occurs and persists until metaphase.[3]. The last anther listed in Table II which has the highest interlock frequency also has the lowest chiasma frequency. This could result form an incomplete recovery following partial desynapsis. (2) Perhaps the end adhesions, noted in certain cultures, are indicative of some force capable of reuniting ends in late metaphase. This would produce a configuration similar to the so-called terminalized chiasma (see arrows in Figure 5*B*). (3) By reference to the time column in Table II, it can be seen that the last two anthers listed may have been excised after the beginning of diplotene. If such were the case, the increase in interlocking must have occurred during diplotene or diakinesis.

The above evidence, along with the inadequacy of the generally accepted theory of chiasma formation to explain the increased interlocking, lend support to the suggestions of Schrader,[5] Cooper,[4,1] and others that chiasmata seen at metaphase I are not proof in themselves that crossing-over has occurred. The alternate explanation of interlocking given above is applicable to anthers that reach metaphase I on the plant. It may also explain some of the extreme variations in interlocking noted by Sax and Anderson,[4] as well as the seasonal variations mentioned in this report.

TABLE I. Chiasma frequency and interlocking at metaphase I in ten anthers from different flowers of Clone 5 plants ($n = 6$) grown in the greenhouse. Fifty cells were analyzed from each anther.

Mean number of chiasmata per cell	Mean number of interlocks per cell	Percent of cells with interlocks
12.14	0.14	11
12.02	0.20	19
11.90	0.21	19
11.76	0.24	24
11.40	0.27	24
11.58	0.28	23
11.12	0.38	35
11.70	0.42	28
11.64	0.43	33
11.81	0.51	34
Mean = 11.71 ± 0.073	Mean = 0.31 ± 0.036	Mean = 25

TABLE II. Chiasma frequency and interlocking at metaphase I in eleven anthers of Clone 5 excised and at 30°C. Fifty cells were analyzed from each anther.

Mean number of chiasmata per cell	Mean number of interlocks per cell	Per cent of cells with interlocks	Stage at excision	Hours in culture
* 11.35	0.20	15	mid-pachytene	24
* 12.74	0.29	25	late pachytene	18
11.12	0.59	47	mid-pachytene	23
12.06	0.77	54	mid-pachytene	23
12.83	0.80	61	late pachytene	19
11.45	1.00	50	late pachytene	17
11.95	1.02	76	mid-pachytene	18
12.25	1.08	72	late pachytene	19
11.80	1.09	58	late pachytene	24
11.75	1.25	75	late pachytene	16
10.00	1.30	80	late pachytene	15
Mean = 11.69 ± 0.22	Mean = 0.99 ± 0.073	Mean = 64		

*All data available on interlocking in anthers cultured at 30°C., are recorded, but it is doubtful if interlocking in the first two listed was affected. Since interlocks in these two are well within the range of the controls, their frequency was not included when the mean interlocks for anthers with increased interlocking was calculated.

Literature Cited

1. Cooper, K. W. *Jour. Exp. Zool.* 108: 327-332. 1948.
2. ———— *Genetics* 29:537-568. 1944.
3. Darlington, C. D. Recent Advances in Cytology. Churchill, London. 1937.
4. Sax, Karl, and Edgar Anderson. *Genetics* 19:157-166. 1934.
5. Schrader, F. *Science* 109:155-159. 1948.
6. Taylor, J. H. *Rec. Gen. Soc. of Amer. for 1948,* pp. 60-61.
7. ———— *Jour. Hered.* In press.

◆

A BUD VARIATION IN BOUGANVILLEA

Fernando Villamil G*

YELLOW-AND-GREEN

Figure 6

A striking variegated pattern appeared as a branch of a normal green plant—the first recorded in this species.

In 1946, a plant of Bouganvillea, with pink-salmon bracts was found growing as a fence-cover in one of the houses of the personnel of the Palmira Agricultural Experiment Station, Colombia, S. A. It bore, as a separate branch, a new shoot with leaves of a variegated form displaying a well marked yellow pattern (See Figure 6). Some days later a laborer, doing cleaning work,

*Ingeniero Agrónomo, Sub-Jefe Oficina Central de Experimentación e Investigación, Div. Nal. de Agricultura de Colombia, colaborando en la Estación Agricola Experimental de Palmira. Profesor encargado de la cátedra de Genética en la Facultad Nal. de Agronomía en Palmira.

inadvertently destroyed the twig. Fortunately, however, after several weeks a new growth began and the shoot was restored. It produced leaves with the same pattern as before. After reaching a woody stage, the branch was removed to a nursery plat. Finally it was transplanted to the field, again as a fence-cover.

The plant has now been propagated from cuttings which resulted in producing the same variegated yellow pattern. One of these plants has again produced a reverted form, that is a branch bearing the normal green leaves of Bouganvillea. As far as the writer is aware, this is the only bud variation heretofore reported on branches of Bouganvillea.

Variegated leaves are characterized by large irregular yellow patches of chlorophyll-deficient tissue, spreading at both sides of the midrib and forming areas of variable size and shape. In no cases are the leaves almost or wholly white or yellow. The young twigs have a light pink color, contrasting with the light green color of the young twigs in the original stock.

✦

Conway Memorial Fellowship

The Conway MacMillan Memorial Research Fellowship in Botany is available at the University of Minnesota for the year 1949-50. This Fellowship, which was established three years ago by Mr. Charles J. Brand of Washington, D. C., in honor of the late Professor Conway MacMillan, is awarded annually to doctoral students of promise and ability in the field of botany in its broadest sense. Applicants should have their master's degree from the University of Minnesota or an institution of learning of similar standing, or equivalent experience in their fields of concentration. According to the terms of the gift, special mention is made of students from the University of Chile and the Catholic University of Chile. The recipient receives a stipend of $1200 for the academic year and is exempt from tuition in the Graduate School. All inquiries should be addressed to: A. O. Dahl, Chairman of the Conway MacMillan Fellowship Committee, Department of Botany, University of Minnesota, Minneapolis 14, Minnesota.

✦

Panic and Perspective

Second, is the matter of panic. I say second on the basis of the Japan experience, because the Japanese don't panic easily (if ever). It is possible that other nations, our own not least of all, may be highly vulnerable to a mere *threat* of atomic warfare, because of the sense of mystery about radiation. Panic can be a potent factor in modern war, and the danger of it could far exceed that of atomic war alone. There is a very thin line separating false security from unreasoning fear, and one gets the impression that people dash back and forth across this frontier like jittery ostriches. Only knowledge can broaden this line to a place where people can stand. Despite all that has been written and said about bacteriological warfare, I am sure that this occupies a less esoteric and frightful place than the atom and its radiations in the public mind because everyone has a homely familiarity with infectious disease. And, of course, the biological horizon that ought to frighten us silly (I refer to overpopulation) doesn't even occur to anybody but savants. —Austin M. Brues, (member of the staffs of the Argonne Laboratory and the Institute of Radiobiology and Biophysics at the University of Chicago)—*Bulletin of the Atomic Scientists*, November, 1948.

—Yet the Japanese, without knowledge, kept the panic-line a solid wall. We, with knowledge and good intentions, stand helpless before the Puerto Rico paradox. Strange!

✦

Head Injuries in Cases of Feeble-Mindedness

One thousand consecutive records of a large New York State institution were investigated to find potential cases of postnatal cerebral trauma.

An investigation such as has been indicated in this study is the most complete method of evaluating the possibility of mental deficiency as a result of cerebral trauma.

Approximately one and five-tenths per cent of institutionalized mental defectives can be considered to be the result of postnatal cerebral trauma.—Waldemar H. Boldt, *Amer. Jour. Ment. Def.*, Oct. 1948.

ERICH VON TSCHERMAK-SEYSENEGG

Last of the Surviving Rediscoverers of Mendel's Law

FELIX KIEFER
Schwarz Laboratories, Inc., Mount Vernon, New York

DURING the closing years of the nineteenth century, three research biologists, in Germany, Austria and Holland had come to a point in their investigations where the key to the ancient mystery of heredity seemed just within their grasp. In preparing reports of their researches for publication, each of them independently uncovered, in a dusty and neglected corner of the literature of biology, a modest paper published a generation earlier by an unknown friar, Gregor Mendel, of Brunn, in what is now Czechoslovakia. In Mendel's report on experiments of hybridization in peas, they found a lucid and detailed explanation of the principle of "atomic heredity," which was a brilliant confirmation of their own emerging intuitions.

Astonished that this epochal discovery had so long escaped the notice of science, each of the three workers hurried into print to announce the rediscovery of Mendel's "laws" of heredity. All three papers were independently in process of publication at the same time, and all of them appeared during the year 1900. Their publication created a sensation in biological circles, and almost overnight established the science of genetics. Equipped with the sharp new tool, the Mendelian concepts, the scientific study of heredity grew amazingly during the first decade of the twentieth century.

This fascinating chapter in biological history is a basic part of the folklore of genetics. Karl Correns, Hugo De Vries, and Erich von Tschermak each made a place for themselves in the new science they had played such an important part in founding. Today, von Tschermak is the sole survivor of this almost mythical triumvirate of half a century ago.

Like Mendel, von Tschermak used the pea for his study of hereditary phenomena and he found that the rules derived from the crossbreeding of peas could be applied generally to the whole field of hybridism and the characteristic developments relating the progeny to their predecessors.

If we join in giving honor where honor is due it appears that large parts of Europe and the world in general, owes a debt of gratitude to von Tschermak, now past his 75th birthday, who, ever since his rediscovery of Mendel's rules has made it his task to apply them to practical plant breeding in which he was so extraordinarily successful.

Dr. Heinz Bruecher, now professor at the University of Tucuman, who had been one of von Tschermak's co-workers, introduced me to the latter at the home of his sister-in-law near St. Wolfgang in the Salz Kammergut. With great mental alertness and exuberance, which are his, von Tschermak propounded his plans to us. Most recently he has been working on parthenogenesis and so-called "Reizfruchtung," fertilization by irritation, carrying out his experiments on a diminutive scale in the small vegetable garden surrounding the house. He has already succeeded in creating germination of various plants, including grains, peas and some flowers by carefully castrating the blossoms and imparting "Reizstoffe" such as Vitamin B_1 and C and such growth-promoting factors as are contained in grain-flour, to the intact female sexual organ. The seeds he thus obtained germinated and formed plants identical with the mother plant. More

*See also THE JOURNAL OF HEREDITY 39, 9 p. 247 (1948). Dr. W. J. Spillman's Discoveries in Genetics, by L. P. V. Johnson. An Evaluation of his Pre-Mendelian Experiments with Wheat.

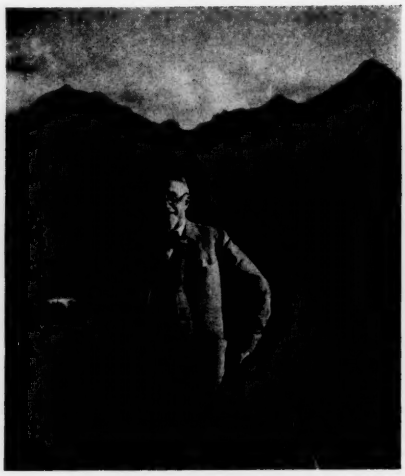
recently von Tschermak tried to use inorganic powdery materials such as chalk and talcum to perform his "irritation pollination" and he has obtained indications that germinating seeds can develop by irritation only without the addition of hormones or vitamins. Winter barley proved especially responsive to such treatment. These questions are filling his imagination and he devotes most of his time to this painstaking work whose final result poses such an appeal for patience to the experimenter.*

Wartime Hardships

During the war von Tschermak's home in Vienna was badly damaged, with most of his scientific equipment destroyed. However, his changed circumstances have done little to impair his happy countenance and friendly philosophy towards life, an attitude not too uncommon amongst the warmhearted populace of those parts. Gratefully he dwelt on the kind and so very helpful remembrance expressed by foreign colleagues as well as admirers of his scientific and practical achievements who have not only replaced some of his scientific tools but at the same time remembered his physical needs. He becomes indeed very enthusiastic when mentioning those ingeniously compiled CARE packages whose donors have endeared themselves to him very deeply. While his love for Austria, his one time so beautiful home country, is beyond dispute, he has a great admiration for America which he has visited on several occasions; but he expressed also a great adherence to Germany, and he made it no secret that he could not see any prospects for the future of Austria except in a reunion with Germany and eventually in her incorporation in the larger union of Europe.

Born on Nov. 15, 1871, von Tschermak looks back on a lifework which was characterized by the practical application of his scientific discoveries to plant breeding. Austria as well as the whole of Middle and Eastern Europe owe him much for the many new kinds of plants which he has developed for the agriculture of these areas. Numerous students and successful plant breeders emerged from this Institute for Plant Culture which had been under von Tschermak's direction for 35 years. With sharp criticism he relates how after the war this important research center for plant genetics was taken over by the Academy for Soil Cultivation in Vienna and thus lost its independence and incidentally its most valuable teacher. While it was presumably economic considerations which prompted this move to those who witnessed the accomplishments of von Tschermak's institute it must appear as one of the most unfortunate consequences following the wake of the last war.

Erich von Tschermak, as may be expected, belongs to that older school of classical scholars who were still able—before the expansion of scientific explo-



THE HAPPY HOFRATH

Figure 7

The sole surviving re-discoverer of Mendel's work lives near St. Wolfgang, and in his garden he continues his experiments in plant reproduction and heredity.

*For recent description of this work see *Die Bodenkultur* 1, 1948, pp. 1-9, Kuenstlich bewirkte Samenbildung ohne Befruchtung by Erich Tschermak-Seysenegg, Wien.

LABORATORY CONFERENCE

Figure 8

At 77, Professor von Tschermak is busily investigating the phenomenon of parthenogenesis, and is engaged in research to use "irritation pollination" to maintain matroclinous lines.

ration forced increased specialization—to consider such fields as biology as an undivided whole, taking into focus any of the many problems which he met on his way. His numerous publications on a variety of subjects bear this out. They include questions on theoretical genetics, problems of crossbreeding, the theory of cryptomery, as well as problems of a cytological character with hybrids of different species. These investigations of a more purely scientific nature alternated with practical breeding experiments with barley, wheat, rye and leguminous plants as well as with ornamental plants for garden and greenhouse. Already in 1903 von Tschermak began experiments to obtain a better strain of barley for the brewing industry. He started with selective breeding of the Hanna-barley growing in Moravia and succeeded through persistent efforts over a period of more than 30 years in developing the Hanna-Kargyn barley which, besides giving excellent yields, shows a remarkable resistance against droughts. For this reason it has been accepted far to the East in Europe as well as in Asia Minor.

von Tschermak has also devoted himself to the improvement of rye. He concentrated especially on the creation of a summer rye of early maturity which offered greater yields and a better kernel by crossing low yielding summer rye with high yielding winter rye. Such an improved strain would be especially desirable for farming in mountainous regions where the severe and long winters often inhibit the growth of winter rye. Although Professor Tschermak has not fully succeeded because of the slow maturing of the grain, he emphasized the necessity of bringing these experiments to successful conclusion.

With the same purpose in mind, namely to help the mountain farmers of his native country to improve their scarce living where poor soil and climate are

their constant antagonists, von Tschermak produced a fast growing, resistant oat hybrid which he obtained by crossing "Siegeshafer" and "Hungarian 60 day oats." Now he considers the development of "winter oats" which would be most desirable for the drought areas of Central Europe — where only summer oats are known — because these areas have enough precipitation during winter months to support the growth of grain.

For more than 40 years Professor Tschermak has carried out research towards the improvement of wheat. In this he was very successful, by producing a number of new strains with ever greater yields. Although others have stepped into the race and have on occasion outdone von Tschermak's results, several of his strains such as "Non plus Ultra," "Moravia," and "Tschermak's Begannter Marschfelder" have remained popular in Central Europe to this day.

Genus Hybrids

von Tschermak entered also the difficult problem of "genom-synthesis" which involves the artificial union of different types of plants such as wheat and rye to obtain an entirely new species. If applied to grain one might want to combine in the new plant the high resistance of rye against low temperatures and its modest soil requirements with the high yields and excellent flour quality of wheat and perhaps with the proverbial toughness of wheat-grass (*Triticum repens*).

He was able to produce not only constant wheat-rye hybrids (Triticale) but also crossings between wheat and various grasses to form new, synthetic types of grain. The synthetically produced Agronticum, Agrocale, Aegilotricum or Haynaldtricum open wide aspects to plant breeding for future development and exploitation. On the other hand they represent one of the most important scientific contributions towards the interpretation of the variation of species in nature and the processes involved in their formation.

"Still Much to Do"

von Tschermak quite naturally extended his endeavors towards the creation of improved or new species of grain to other kinds of crops such as beans, peas, lentils and vegetables as well as to that of flowers. When, as a consequence of the war, the immense fat crisis developed in Europe, Tschermak turned to the cultivation of oil plants. He was able to develop a melon of fine edible flesh, whose peelless kernels are especially rich in oil, by crossing two domestic melons of different characteristics. It is expected that the new plant will contribute considerably to the alleviation of the oil shortage if not of Europe then at least within the narrower limits of Tschermak's small country.

As we were listening to the interesting stories of discovery and success in making the fruits of the field give up their secrets and thereby handing to man the tools wherewith to "replenish the earth and subdue it" it was tempting to ask the "Hofrath" (his dignified title of a bygone era), whether he had been thinking of writing down the story of his rich life. Without hesitation came the answer, in fact the only answer which such an active mind as his could give: "that which is important for scientific progress has been recorded already; for more I have no time. There is so much to be done yet."

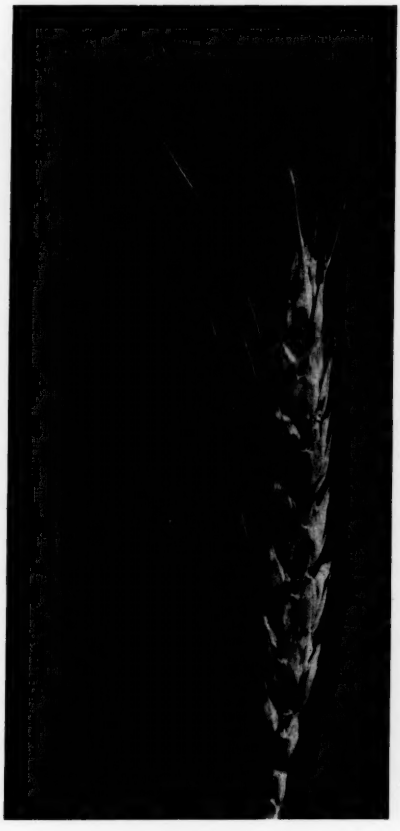
Professor von Tschermak has discovered and is proving in his own way what the wonderous story in Genesis tells us, of how the earth brought forth "grass, and herb yielding seed, . . . whose seed is in itself" . . . And while we admire his great stature as a scientist, his keen thought and experimental art, we believe that the humble and childlike faith which characterizes this happy explorer of the microcosmos of plant life was the key which opened for him door after door in his progress towards the deep secrets of nature.

That he may enjoy this doing for a long time to come is the sincere wish of all who know him.

AN AWN CHIMERA IN MARQUILLO WHEAT

L. P. REITZ*

A SPIKE was observed in a planting of Marquillo spring wheat at Ramona, Kans., July 11, 1940 that was classified as a chimera. It had well developed awns at the apex and along one corner of the spike, while the remaining lemma tips were about the length expected on a normal Marquillo spike. Long tip awns on F_1 hybrids of awned $\times$ awnless plants is a normal condition. The glumes were normal and the rachis tenacious. The spike is shown in Figure 9 and a diagram of the awn development appears in Figure 10. Florets 2 and 19 were sterile.



AWNED AWNLESS

Figure 9

An awn chimera in Marquillo spring wheat, normally a beardless variety. One row of florets bore awns throughout the length of the spike.

Breeding Behavior

The seeds were planted and the order of their occurrence in the spike was recorded. The progeny are shown in Figure 11. All of the seeds from the bearded corner of the spike yielded bearded progeny; there was a solid block of awnless plants rising from seed numbers 20 to 25; both awnless and bearded progeny came at random from the remainder of the seeds in the ratio of 6:5.

Grain from each of these heads was sown in the small grain breeding nursery where the plants were classified at maturity according to awn length on a scale of 1 to 5 with class 2 representing the Marquillo parent. The data are presented in Table I. Again, that group which originated from the bearded side of the spike produced bearded plants only. Likewise, the awnless block represented by seeds 20 to 25 had only awnless progeny. The five bearded plants among the remaining 11 heads bred true for the awned condition but among the six awnless heads there were three which bred true for awnless while the others segregated. In general, the awns on the bearded plants seemed shorter

*Agronomist, Division of Cereal Crops & Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agr. Research Administration, U. S. Department of Agriculture. Acknowledgment is made of facilities used at the Kansas Agricultural Experiment Station, Manhattan, Kans., where the progeny were grown.

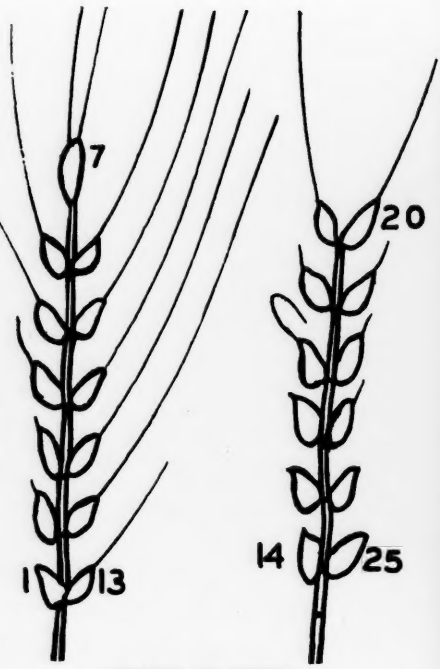
than usual for hexaploid wheat.

Several hypotheses have been considered in an attempt to explain these results. It is obvious that the original chimera was heterozygous for the awning factor. On the basis that the progeny shown in Figure 11 represent a random F_2, the segregation of 12 awnless to 11 bearded would be a very poor fit to the expected ratio of 3:1 ($P = .01$). Seeds 1 to 7 and 14 to 18 gave progeny more in accord with random expectations but the ratio of 6:5 does not improve the fit convincingly. Both groupings fit a 1:1 ratio almost perfectly.

The heterozygous form may have changed by mutation to the homozygous recessive in the tissues giving rise to the row of bearded lemmas and the enclosed seeds, resulting in bearded progeny. There would remain 17 seeds to segregate from the original heterozygote. On this basis the 12 awnless and 5 bearded progeny fit a 3:1 ratio rather well considering the small numbers ($P = .40$). Such an explanation still does not account for the block of awnless plants arising diagonally across the spike from the awned row of lemmas unless chance alone is involved. To explain all of the results other hypotheses, including structural aberrations or abnormal behavior of chromosomes, seem necessary to account for the occurrence of such a lop-sided spike. But in the absence of cytological evidence it has not been possible to prove any one of them. Powers'[6] cytogenetic work showed that Marquillo had greater germinal instability, was less uniform agronomically, and had more natural crossing than Marquis or Thatcher.

TABLE I.—Awn types among F_2 progeny groups compared with the Marquillo check.

Seed No.	Awn type of parent	Awn class and number of plants 2	3	4	5	Total
1	awned	.	15	....	....	15
3	awnless	13	5	....	....	18
4	awnless	12	7	....	....	19
5	awned	....	7	7	....	14
6	awnless	18	....	....	....	18
7	awnless	12	....	....	....	12
8	awned	....	10	3	....	13
9	awned	....	....	6	....	6
10	awned	....	16	3	....	19
11	awned	....	12	8	....	20
12	awned	....	12	11	3	26
13	awned	....	....	....	6	6
14	awnless	13	....	....	....	13
15	awnless	6	12	2	....	20
16	awned	....	11	5	....	16
17	awned	....	....	14	....	14
18	awned	....	9	....	....	9
20	awnless	12	....	....	....	12
21	awnless	14	....	....	....	14
22	awnless	12	....	....	....	12
23	awnless	17	....	....	....	17
24	awnless	20	....	....	....	20
25	awnless	13	....	....	....	13
Check	awnless	11	....			11



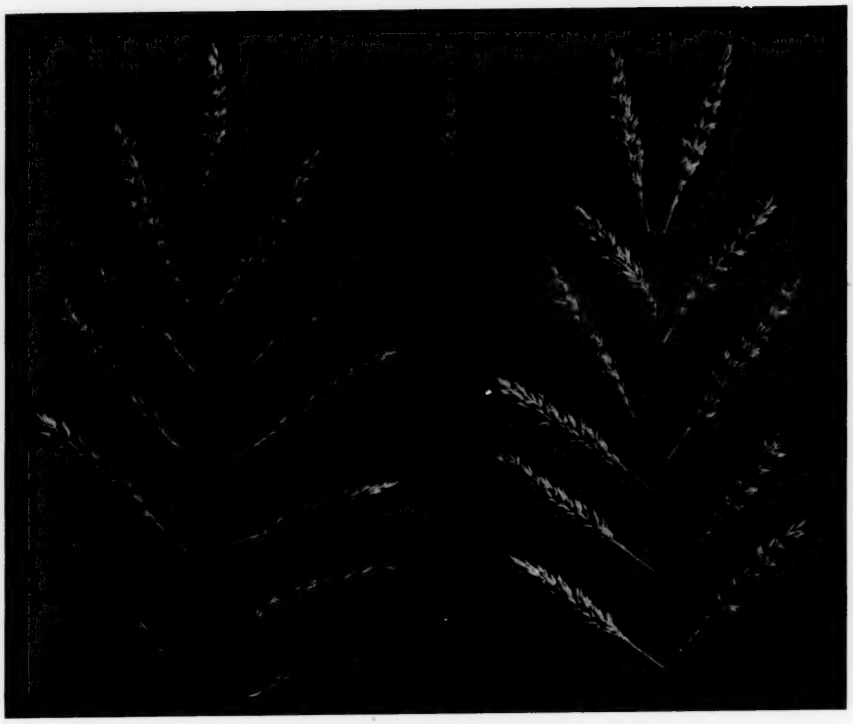
ORDER OF SEEDS

Figure 10

Diagram of awn development on spike shown in Figure 9. Numbers 1 to 25 designate the order of the seeds in the spike.

The diminutive awns which developed on most of the bearded progeny suggest that the awning factor was not the usual gene or genic balance found in fully awned *vulgare* wheat and may involve a gene similar to the awn suppressor identified in Chromosome X by Sears[7] or is related to the awning of speltoids which arise frequently from awnless varieties.[4] There were no other traits observed which would indicate a deficiency or a speltoid complex.

While this chimera follows the gener-



HEADS FROM GRAINS

Figure 11

The progeny from the original chimera arranged in the order recorded in Figure 10. A spike of Marquillo (upper center) is included for comparison.

al pattern described in many genera of plants, no similar spikes of wheat are known to the author where awned and awnless lemmas occurred in the same spikelet with concurrent influence on the germinal tissue. Chimeras frequently give dissimilar progeny from the different sectors. Åkerman[1] reported a speltoid in which six seeds on the affected side of the spike gave five heterozygous speltoid plants and one normal, but five seeds from the normal side gave normal progeny only. He explained the results on the assumption that a mutation in a cell of the growing point gave rise to a speltoid sector but suggests that a kind of segregation process may have taken place. Other speltoid chimeras are known but for the most part the seeds on the spike were not affected in a differential manner. Huskins[4] reviewed several cases of chimeras in wheat and oats. Karper[5] described chimeras in sorghum and cited cases in other plants which were maternally inherited. Chimeras likewise may be due to external factors such as the gall midge[1] and other insects, bunt,[2] frost, chemicals, or unidentified causes.

Ontogeny of the Spike

The observations on this chimera like those on other such forms shed light upon ontogeny of the wheat spike. According to Hayward,[3] who cites the work of Rösler and Percival, new buds are formed from subepidermal tissues. In young plants, the tissue of the bud

may arise from a single apical cell or from a group of several subepidermal cells; in older plants there are two layers of initials within the dermatogen in which the outer one consists of a group of cells and the inner one a single cell. These differentiate the regions of the axis and the floral region. The leaf originates entirely from the dermatogen.

The chimera under discussion shows clearly that the spikelet was differentiated from two or several unlike cells and that a spikelet, considered the taxanomic unit of inflorescence in grasses, has a complex origin. The unlike sectors in this case appeared to run parallel throughout the length of the spike, dividing a series of several spikelets as evidenced by a change in awn type and breeding behavior of the seeds.

Summary

A spike of wheat was found to be a sectorial chimera. Plants from seeds from different parts of the head and the spikelet exhibited unlike awn development which showed that the germinal tissue had been affected. This leads to the conclusion that a spikelet is differentiated from several cells rather than from a single one.

Literature Cited

1. ÅKERMAN, Å. Speltlike bud-sports in common wheat. *Hereditas* 1:116-127. 1920.

2. BRESSMAN, E. N. *Oregon Agr. Exp. Sta. Bul. 281.* 1931.

3. HAYWARD, HERMAN E. The structure of economic plants. Macmillan Co., N. Y. 1938. p. 170-171.

4. HUSKINS, C. LEONARD. *Bot. Rev.* 12: 457-514. 1946.

5. KARPER, R. E. *Jour. Hered.* 25:49-54. 1934.

6. POWERS, LEROY. *Jour. Agr. Res.* 44: 797-831. 1932.

7. SEARS, E. R. *Genetics* 29:232-246. 1944.

✦

BOOK REVIEW SECTION

MARXIST BIOLOGY, FRENCH STYLE

OWING to the notoriety gained by Lysenko and other Russian exponents, the so-called marxist or dialectical biology has acquired the reputation of being a compound of ignorance and charlatanism backed by political chicanery. But it is only fair to note that biologists who contend that principles of Marxian dialectics are useful or even indispensable for correct evaluation of scientific theories exist also outside of Russia. Far from all of them are Lysenkoites. M. Prenant is the most prominent representative of this persuasion in France. His *Biology and Marxism* is an interesting exposition of fundamentals of biology, especially of genetics and evolution theory. The book is liberally peppered with quotations from Engels. These show that Engels was familiar with biological theories of his day, and that Marx, Lenin, Stalin and other Marxist pundits, do not show even that. Except for the quotations, the book could have been written by a biologist unfamiliar with Marxist scriptures and Marxist dialectics. This book surely belongs, in terminology now current in Moscow, to the "reactionary, antipopular, Weismannian - Mendelian - Morganian biology."

The book opens with a sketch of the history of biological exploration of the world and a summary of paleontological evidence for evolution. There follows a discussion of organic adaptation as a product of natural selection, which is interestingly connected with an essay on the origins of life. Here the phenomenon of self-reproduction is stressed as constituting the fundamental property of living matter. Embryonic development is next described as a succession of dialectical crises. The chapter on he-

*PRENANT, MARCEL. *Biologie et Marxisme.* 335 pp. Fr. 225. Hier et Aujourd'hui. Paris. 1948.

redity gives a readable account of the chromosome theory (the description of meiosis is unfortunately inaccurate, however), of Mendel's laws, and of the concepts of genotype and phenotype — all topics proscribed by Lysenko as "metaphysical" and "reactionary." This forces the author to face the Lysenko problem.

One may well understand the acute discomfort of a scientist whose loyalty to a political party requires that he defend and glorify what he knows full well to be negation of truth. But one can hardly excuse the lack of courage and of intellectual honesty in partisans of Marxist biology who, even being out of reach of Lysenko's wrath, nevertheless see fit to condone scientific fraud. Professor Prenant passes the test relatively well. For he accepts Ashby's verdict, that Lysenko's "opinions on genetics may be dismissed as the product of a medieval mind using what is almost a medieval technique." And yet the author insists that the activities of this medieval mind are in some mysterious way useful to Russian and to world science, and refuses to admit that Lysenko is at least morally responsible for the martyrdom of Russian genetics and geneticists. We are told, for example, that "Vavilov died of natural death, in 1943." It is unfortunate that Mr. Prenant, if he possesses reliable information about these matters, failed to tell us just where and under what circumstances Vavilov's "natural" death occurred, and what has happened to Karpechenko, Levizky, Kerkis, and other geneticists who disappeared without trace. And does M. Prenant still believe, as he says in his book, that research in "classical genetics is pursued on a very grand scale and without obstacles in USSR"?

The discussion of the Lysenko issue occupies six pages and Lysenko is very carefully not mentioned in the remainder of the book. The author proceeds with an exposition of theories of mechanics of evolution. Here he rejects Lamarckism and inheritance of acquired characters, which Lysenko now finally admits to be the basis of his Marxist biology. The modern theory based on findings of genetics is accepted by Professor Prenant. Then follows an interesting discussion of the evolutionary origins of human societies and of consciousness. The book concludes with a chapter on "Biological sciences and the conception of the Universe," which is interesting reading despite the avalanche of quotations from Marxist oracles. Now, Professor Prenant is quite aware that most of the makers of biology did not hold the Marxist creed, and that the Marxist family closet contains some skeletons like Lysenko. Of course, Marxists have an answer ready: good scientists, whether they know it or not, are spontaneously dialectic. This, one may suggest, sounds more ingenious than convincing.

TH. DOBZHANSKY
University of São Paulo, Brazil, and Columbia University, New York

◆

A Prophecy

The problem of population is going to be not merely an economist's problem, but in the near future the greatest of all political questions. It will be a question which will arouse some of the deepest instincts and emotions of men, and feeling may run as passionately as in the earlier struggles between religions. The issue is not yet joined. But when the instability of modern society forces it, a great transition in human history will have begun, with the endeavor by civilized man to assume conscious control in his own hands away from the blind instinct of mere predominant survival.—LORD KEYNES.

THE SVALOF PLANT BREEDING STATION

A Review

THIS book* includes a series of separate papers describing the plant breeding work at the famous Svalöf Station of the Swedish Seed Association during the period from 1886 to 1946, inclusive. The foundation, organization, development, and activities of the Swedish Seed Association is described by Ljung. His account includes a brief summary of the changes in cropping practices during the period. There has been a gradual change in the percentage of forage crops grown in Sweden from 27.2 per cent in 1865 to 47.8 in 1945 and a corresponding decrease in small grains. There has been an increased interest in animal husbandry, especially dairy production. This paper describes the major lines of work undertaken during various periods and includes a list of the main workers, a description of the main station at Svalöf and of the eight branch stations which cover the more important agricultural districts of Sweden. It includes also relationships with the General Swedish Seed Company with respect to seed propagation and distribution, income during various periods and sources of the same. Some idea of the extent of these operations can be gained by the number of plots grown during different periods. In 1945 they totaled 38,946 at the main station and 39,802 at the branch stations.

"The Climate and Soils of Sweden," by Andersson, includes brief descriptions of geographical position, altitudes, temperatures, length of growing period, monthly precipitation and soil characteristics. The fourteen natural agricultural regions and the major cropping practices are described. The wide differences between regions emphasizes the need of localized breeding and the reason for the development of branch stations. "The Breeding of Self-fertilized Plants by Crossing" by Akerman, the present Director, and MacKey, give an excellent picture of the methods of breeding that have been used and their development. Detailed diagrams included show that the earlier pedigree methods used from 1915 through about 1928 consisted of a combination of spaced plant progenies in comparison with preliminary yield trials from seed of the remainder of the line from about F_4 until the selection of elite lines for increase in later generations. Individual plant progenies are used to isolate pure breeding lines. A somewhat different method is illustrated for a winter wheat cross that was grown in spaced population plots in F_2 and F_3, in spaced plant progenies in F_4, in yield trials in F_5 and F_6 when all but a few lines were discarded because of a lack of winter hardiness and in plant selections as well as comparative yield trials in F_7. After three subsequent years of yield trials, desirable new varieties were selected for increase. The population, or "bulk" method as it is commonly called in this country, is explained and presented in diagrammatic form. The method has been used successfully at Svalöf. In a diagrammatic illustration of cross breeding in peas, individual plant selections were made in F_6 and the first yield trials were made in F_8. This paper discusses also early comparative tests of crosses in F_2, multiple crosses, other experimental technics and selection methods. The writers conclude, however, that, "Plant breeding is too much of a personal task, a varying problem and a living question to be arranged into a definite mechanized system."

The breeding of winter wheat, spring wheat, and oats by Akerman, outlines earlier studies, progress in solving problems and present problems which remain to be solved. A list of new varieties, the date of their production, comparative yields and other characters, where the yield of old "land" varieties was taken as 100, are given for these crops in diagrammatic form. Continuous progress in obtaining better varieties is apparent from the time of earlier productions to the present.

Several separate papers, on breeding of various crops, cannot be discussed in great detail. These include barley by Nilsson Ehle, rye by Ljung, potatoes by Tedin, root crops by Josefsson, oil plants by Andersson and Olsson, flax and hemp by Granhall, hons by Josefsson and tobacco by Tedin. While combination breeding with barley has given valuable results as with wheat and oats, Nilsson-Ehle believes induced mutations offer new possibilities. He was primarily responsible for the organization of the cytogenetics department. Rye has been bred both by a degree of inbreeding and family breeding in isolated plots. Seven varieties of potatoes have been selected and introduced, two of which have been grown widely in

*Svalöf 1886-1946 History and Present Problems. 378 pp. Lund 1948.

Sweden. Valuable results have been obtained with the other crops.

Inbreeding and Crossbreeding

Nilsson-Leissner discusses "Natural Selection and the Breeding of Cross-fertilizing Plants," with particular attention to the selection of ecotypes which have developed by natural selection under different environmental conditions. A knowledge of underlying principles has led the breeder of these crops to select the more promising types after various varieties of crop plants have been grown under different conditions at the main and branch stations. The method used is of interest to other breeders. Seed of various strains was sown in isolated plots at the various breeding centers. Seed was harvested, in the first, and where possible in the second and third years and new seed plots were established. Comparative yield trials were made from seed of the same and from different stations. Strains isolated by these methods often have given a marked increase in production in the locality to which they have become adapted. Valuable selections have been obtained from work started 12 to 15 years ago with red clover, white clover, timothy and meadow fescue.

Julén discusses "Inbreeding in Herbage Plants." A method of breeding that has proven of value has been used in the development of Primus and Gloria varieties of timothy, Skandia II and Brage cocksfoot, Vikig red fescue and Viktoria perennial ryegrass. Beginning from a single plant the method employs selfing in the first generation followed by sib-pollination in the subsequent ones. This is accomplished by selecting the best plants from extensive collections of material. Each is vegetatively propagated in small plots and the various clones are studied. Selection is practiced for desirable agronomic characters, resistance to diseases, etc., and the more desirable clones are again vegetatively propagated and each isolated by distance. Seed from these plots is used for yield trials and the more desirable lines are reproduced on a large scale, elite seed being repeatedly taken from the isolated clonal propagations. Julén also studied the effects of enforced self-fertilization with several species of clover, blue lucerne, timothy, brome grass and other crop plants, including studies of seed setting and degeneration. In these studies there has been a general occurrence of a reduction in vigor after inbreeding in cross-fertilized pasture grasses. Relatively vigorous inbreed lines have been isolated in timothy and red fescue. Single and double crosses between four I_4 lines of timothy were compared with clonal plants of the four I_0 lines, of the I_3 and I_4 generations, and with seed progenies of the Gloria variety. The yields of both the single and double crosses were superior to that of Gloria. The inbred lines used excelled in vigor under selfing.

Torssell describes "Different Methods in the Breeding of Lucerne." The material used consisted chiefly of two varieties, Franconian and Grimm, that were known to have cultural value in Sweden. He concluded that seed setting seems to take place rarely without tripping, although two or three per cent of untripped flowers set seed. Approximately 35 per cent of flowers set fruit when selfed. Wholly self-sterile plants were very rare. Self-sterility increased rapidly with continued selfing. Usually the application of extraneous pollen to non-emasculated plants produced crosses. In a comparison of average green weights in different generations, where 100 is taken as the yield of the original population, I_1 gave a yield of 80 to 90, I_2 60 to 70 and I_3 50 to 60. It was difficult, as a rule, to carry selfing beyond I_3, and in some cases to I_4, because of the great decline in self-fertility with continued selfing. Some crosses of inbreds were superior to the non-inbred initial material. It was concluded that the complex characters which constitute the plant's ability to produce green weight are governed by a large number of polymeric dominant genes with limited additive effect. Segregation of these genes takes place with inbreeding, reducing the number of dominant genes. It was concluded also that the cumulative effect of heritable characters that affect development does not stand in arithmetical proportion to the numbers of pairs of dominant genes concerned. From this it follows that the number can be reduced, within a certain limit, without a marked effect upon green weight. If this limit is exceeded, a considerable degeneration sets in. In later generations degeneration under continued inbreeding is less with each succeeding generation until with complete homozygosis the inbreeding minimum is reached.

Four methods of breeding alfalfa have been followed at Ultuna:

(1) Inbreeding long pursued and crossing of unrelated inbred offspring thus obtained.
(2) Self-fertilization in one generation only. The best descendants (I_1) are reproduced, each separately, through sib crossing.
(3) Selection from a series of descendants after flowering of the mother plants under conditions of open pollination. Family breeding.
(4) Natural adaptation of foreign populations to environment through repeated seed production in successive generations, with the separation of the populations in question within the region concerned.

No systematic trial of different combinations has been made of inbred material from method 1. F_1 generations were produced through artificial crosses between plants belonging to different inbred lines and a considerable number of these were intercrossed. Strain 0604 was produced from intercrossing 10 F_1 generations,

which were obtained from crossing unrelated inbred lines. This strain did not greatly exceed ordinary Grimm in productivity.

In method 2, I_1 descendants were selected which exhibited the least inbred degeneration. Several of 10 I_1 descendants, tested in yield trials, yielded as high or higher than Grimm. These were separated in the multiplication of selected descendants and each was multiplied through sib crossing. Strains 0601 and 0602, increased in this way, and selected from Lyman's Grimm according to this method, were compared in yield trails with Grimm. Both yielded significantly more than Grimm.

Method 3 has been used as complementary to methods 2 and 4. Four strains bred by other methods were used for the initial material and their most productive descendants multiplied jointly. Yields were considerably improved by this further selection and combination over that of the original strains.

Method 4 gave promising results, the yields in comparison with Grimm comparing favorably with those from method 2.

"Local Plant Breeding and Testing at the Branch Stations" by Åkerman gives an interesting picture of the collaboration between the main and branch stations. In addition to testing varieties produced at other Swedish breeding centers and from foreign countries, important varieties for local conditions have been selected at the branch stations. Valuable basic information has been obtained for phenological and biochemical studies.

"Conditions of Cultivation and Breeding Problems for Cereals and Herbage Plants in Norrland" are described by Erik Åkerberg. This paper is of particular interest in its relation to the effect of environmental conditions, —hours of sunlight, length of growing period, temperature and precipitation, — in their effect on cereals and herbage plants of the same varieties when grown in Norrland and in other regions in Sweden. The same varieties of small grains ripened in a lower number of days in the North than at the southern stations. Strains of herbage plants adapted to northern conditions were superior to those selected in Southern Sweden.

Cyto-Genetics

"The Cyto-genetic Department 1931-1947" by Levan gives a brief history of the origin and work of the department. High chromosome forms of 36 plant species or species hybrids have been produced. Early methods of inducing polyploids included hybridization, heat treatment and the twin method. Colchicine has been used largely since 1939. Standard treatments have been developed for different crop plants. Levan states, "Different types of plants show varying adaptation to polyploidy breeding." The following conclusions are reached,—"(1) low chromosome plants are better than high chromosome plants, (2) allogamous plants are better than autogamous, and (3) plants cultivated for vegetative yield are better than plants grown for seed yield." Mangels, sugar beets, red clover and alsike fulfill all three conditions while rye and mustard fulfill only conditions (1) and (2).

Induced allo- or autopolyploids are not directly comparable with old spontaneous polyploids. It was concluded that doubling of chromosome numbers, in some way, causes a serious disturbance of genotypic balance. When grown under optimum conditions, for example, tetraploid red clover exceeded diploid in green matter by 100 percent. However, under less favorable conditions the polyploid red clover was less desirable than the diploid. Stomatal control functions less exactly in the polyploids. Thus in hot dry conditions polyploid beets, mangels and red clover wilted much more severely than diploids. Winter hardiness, disease resistance and seed production of induced polyploids has been lower than that of comparable diploids. Within a species some polyploid plants were much superior to others. Subsequent breeding with polyploids after their production has led to a great improvement in their characters. About 20 individual polyploid plants of each of 20 strains of red clover, 10 of alsike and 10 of white clover have been produced. These will be grown at the central and branch stations. Further selection and breeding with this type of material has given marked improvement and continued work along this line seems of plant breeding importance.

Studies on induced polyploidy of cereals were started originally by Müntzing who was Director of the Cytogenetic Department during 1931-39. In 1938 the work was transferred to the Institute of Genetics at the University of Lund which cooperates with the Plant Breeding Institute at Svalöf. Müntzing describes rye-wheat hybrids, and tetraploid barley and rye. Various ($2n = 56$) Triticale hybrids produced by him and similar hybrids obtained from Rimpau in Germany and from Russia, were studied by Müntzing. These are largely self-fertilizing particularly in lines with normally dehiscing anthers. Some lines with poor ability of the anthers to dehisce were often cross-pollinated. Further cross breeding and selection with the original wheat-rye Triticales has led to the production of more promising wheat-rye types with higher protein content than wheat, remarkable baking properties and other desirable characters. So much progress has been made that it seems possible to produce $2n = 56$ chromosome hybrids that should be valuable crop plants. Five of the better selections outyielded the Scandia III wheat variety in 1946. Primary tetraploids in barley show several gigas characters. They excel in kernel size, high protein content, and have marked ability to resist lodging.

Yield of grain of primary tetraploids was about 1/3 of diploids. Combination breeding and selection from the primary tetraploids has produced tetraploids averaging 70 per cent of normal. Somewhat more promising results have been obtained with tetraploid rye than with barley.

Gustafsson and MacKey describe "Mutation Work at Svalöf," including spontaneous and induced mutations. They state that a plant breeder can produce barley strains with stiffer straw by selecting erectoides mutants, arising after an irradiation of 10,000 *r*-units to a number of two per 1,000 spike progenies. They state, "Approximately every tenth isolated mutant is high yielding."

"Cereal and Chemistry Laboratories" are described by Lindberg and the Publications of the Association are discussed by Frőier.

The various papers present an interesting summary of the theoretical bases of the breeding methods used with various crop plants, a general picture of the accomplishments both from the theoretical and practical standpoints and outline new problems to be solved. Such summaries are of value to plant breeders and others throughout the world.

University of Minnesota H. K. HAYES

✦

IN PRAISE OF THE QUARTER HORSE

AUTHOR Nye in common with most other ranchers in the Southwest is passionately fond of the Quarter Horse and presents* in him the embodiment of most of the good traits in horseflesh.

The first chapter is devoted to historical backgrounds and to the present status of the breed. Quarter Horses derive their name from quarter-mile racing for which they are especially selected. Their usefulness on the ranch, in the rodeo and in polo is not only dependent upon lightning speed but also upon intelligence, courage, maneuverability and many other traits. Fussiness about pedigree and pulchritude gives way in this breed to speed and to manner of going.

Two registry associations with similar registration qualifications have developed for this young breed: The National Quarter Horse Breeders Association, and The American Quarter Horse Association. Some are registered in both associations—equine joiners. In effect there is a third registration because all horses which race on tracks recognized by the American Quarter Racing Association must be identified with reference to ownership, pedigree, color, etc.

The main body of the book is in biographical form and concerns 24 living sires. Ancestry, performance, individuality, progeny, and ownership are woven into readable vignettes. Much colorful, some quite horsy, language is used. The book is enlivened also with spectacular races, horse trades and action photographs.

Horses are notoriously adept at finding danger spots, particularly to the feet and lower legs. One learns that many Quarter Horses are injured by exposure to wire fences and other hazards and that some of the truly great Quarter Horses have raced when they were totally unfit for the track. Illustrating the latter point, as a seven-year-old and untrained for racing, Joe Reed II was entered in a 440-yard race only a few days after cutting the coronary band in his right front foot. Actually a cripple, he won the race. A week later, "his foot was worse," but he won in "the fastest time he ever made." In the same tradition, a week later "without being out of his stall all week," he won his last race "with blood spurting from his foot every stride of the way." Hot blooded horses seldom qualify as pets but Mr. Nye states that he has observed the owner's three-year-old youngster "playing around on the ground in the shadow of Joe's belly, crawling around in and out of his legs and turning somersaults between his hind legs." Curiously enough, several other stallions are described as unusually

*NYE, NELSON C. *Outstanding Modern Quarter Horse Sires.* William Morrow & Co., New York, 1948. $5.00.

docile and affectionate animals.

Horsemen in general are rugged individualists, and belonging naturally to the group was a certain member of the Cloth referred to as follows: "The Methodist Bull, in Old Joe Bailey's pedigree, was owned by a Methodist minister who drove him to a buggy and preached to the people in the morning and ran him in races in the afternoon."

The social calendar of California-owned Colonel Clyde involves artificial insemination. One of his owners states: "We collect semen on our ranch under scientific conditions, and airmail to any point in the United States, guaranteeing live foal." This represents a very bold commercial venture in horse breeding.

According to Oliver Wendell Holmes writing is "like shooting with a rifle; you may hit your reader's mind, or miss it." Nye's hit may well be a bull's-eye for those already acquainted with the Quarter Horse, but for the general reader the score will be less impressive.

DEWEY G. STEELE

University of Kentucky

✦

THE FORMATION OF FLOWERS

THIS book* deals primarily with flower formation, and how various external factors affect this process. The effect of subjecting germinating cereal seeds to prolonged periods of cold (vernalization) is ably summarized by Whyte, who recently published a book on the subject. Flower induction by different lengths of day and night (photoperiodism) is reviewed by Murneek. Fourteen other authors, prominent in their field, deal with various aspects. This authoritative presentation will bring the reader up-to-date. In addition to being authoritative, the material is presented in a most attractive form. Portraits of pioneers in the field and reproductions of title pages of some early papers on vernalization greatly enhance the pleasure of reading the book. The scientific material is also effectively illustrated by graphs, charts and photographs. Of special interest in this regard is the reproduction of a chart by Blaauw and his associates dealing with the effect of storage temperature on the flower initiation within the tulip bulb. This work is relatively unknown in this country and Went has done us a service by reviewing it.

At present practically nothing is known about the biochemical fundamentals of flower formation. One gets the impression, however, that great discoveries in this field are just around the corner. In this respect the brilliant contribution of Borthwick, Parker and Hendricks of the Bureau of Plant Industry makes fascinating reading. Instead of assuming that under the influence of light a substance is formed in the leaf which ultimately causes the plant to flower, they reason that flower initiation is controlled by a substance produced in the leaves which is inactivated under the influence of light. It seems to the reviewer that here we have a reasonable basis for a biochemical approach to flower formation. We could ask ourselves which biochemical process in the plant is enhanced in the dark and by periods of cold, and supressed by light. If we do, the formation of plant acids presents itself. Could it be then that the tricarboxylic acid cycle is a controlling agent in flower formation?

Almost all articles in the book mention the magic word "hormone," in a vague sort of way, but only the contributions of Thimann and Murneek make brief mention of the pineapple, the only plant known so far, in which a known hormone (auxin) has been shown to induce flowering. It is a pity that the contributor of the generally good section dealing with "hormones in relation to vernalization and photoperiodism" seems unaware of the auxin work in pineapples, as he could have used it as the first example where a pure substance has been substituted for low temperature. He also might have found support in it for Cholodny's hypothesis that auxin is involved in the flowering processes.

For readers interested in the broader aspects of photoperiodism there is an enjoyable article by H. A. Allard, one of the originators of the study of photoperiodism, on the "Length of day in climates of past geological eras."

This stimulating book will find an important place on the reference shelf of all interested in flower formation and in its many ramifications.

J. VAN OVERBEEK

Shell Agr. Lab., Modesto, Calif.

*Vernalization and Photoperiodism, A Symposium organized by A. E. Murneek and R. O. Whyte. Chronica Botanica Co., Waltham, Mass., 1948. $4.50.